A description of the reproductive behaviour of the endangered Iberian cyprinid *Chondrostoma lusitanicum* Collares-Pereira 1980 in captivity

Vera Carvalho, Joana I. Robalo, Vítor C. Almada
Unidade de Investigação em Eco-Etologia, Instituto Superior de Psicologia Aplicada, Rua Jardim do Tabaco 44, P-1100 Lisbon, Portugal. e-mail: verac@ispa.pt

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Abstract. In this paper we describe, for the first time, the reproductive behaviour of the rare Iberian cyprinid fish *Chondrostoma lusitanicum*, endemic to Portugal. The species is an egg broadcaster releasing adhesive eggs. Spawning aggregations may involve large numbers of fish but within a group, short sequences of courtship and spawning typically involve one female and one or a few males. Males follow females touching them frequently and at spawning press the female body against the available objects. Males perform circles that may help to retain a female in a given area. A special behaviour is described for females with the likely function of attracting males and initiating courtship.
Key words: *Chondrostoma lusitanicum*, cyprinids, freshwater fish, female behaviour, spawning, minnow.

Resumen. *Descripción del comportamiento reproductor del ciprínido ibérico amenazado* Chondrostoma lusitanicum *Collares-Pereira 1980 en cautividad.* En este artículo se describe, por primera vez, el comportamiento reproductivo del escaso ciprínido ibérico, *Chondrostoma lusitanicum*, endémico de Portugal. La freza puede implicar a un gran número de peces pero siempre dentro de un mismo grupo, de esta forma, las breves secuencias de cortejo y freza son realizadas normalmente por una sola hembra y uno o varios machos. Los machos siguen a las hembras golpeándolas frecuentemente y, en la freza, comprimen el cuerpo de la hembra contra los objetos disponibles. Los machos realizan círculos que podrán ayudar a retener a la hembra en un área determinada. Se describe un tipo de comportamiento en las hembras, que parece jugar un papel de atracción sobre los machos y de iniciación del cortejo. La especie es una «difusora» de huevos liberando huevos adhesivos.

Introduction

The family Cyprinidae is the largest family of freshwater fishes (Nelson, 1994). Most known taxa in the Iberian Peninsula are endemic (Alves & Coelho, 1994) and classified as endangered (10 out of 15) in the Portuguese Vertebrate Red Data Book (SNPRCN 1992), mainly due to anthropogenic factors leading to habitat destruction.

Chondrostoma lusitanicum Collares-Pereira 1980 is a small cyprinid endemic to Portuguese waters, present in shallow streams with medium flow currents and some vegetation on the banks (e.g. Alves & Coelho, 1994). It is listed as rare in the Portuguese Vertebrate Red Data Book (SNPRCN 1992) and it has a restricted distribution area, covering some small coastal streams, slightly north of the Tagus mouth, some scattered tributaries of Tagus and Sado drainages and the southern drainages of Mira and Arade (Collares-Pereira, 1983; Alves & Coelho, 1994; Pereira, 1995). As a rare species, it is important to understand all aspects of biology for proper conservation. However, the reproductive biology of this species is unknown and its breeding behaviour and that of other closely related species of Iberian *Chondrostoma* is as yet undescribed.

The aim of this paper is to describe the reproductive behaviour of *C. lusitanicum* in captivity, considering the fact that knowledge about the reproduction modes of the species may be important in conservation strategies (Johnston, 1992).

Methods

Twenty fishes, approximately half of each sex, were collected by hand net from a small independent coastal occidental stream (Ribeira da Samarra), near Lisbon, in the summer of 1998 and were raised in an outdoor aquarium (150×50×70 cm) under natural conditions of light and temperature. The aquarium was provided with large stones and water plants and the fishes were fed with fish commercial flakes and chironomid larvae. Although not monitored daily, the temperature ranged from about

10 to 22/24 ºC. All fishes were adult (70-100 mm total length) and sexually mature at the time of this study. These values are common in adults collected in the field. The species reaches a maximum of about 145 mm (according with the extensive sample of Collares-Pereira (1983)).

About 100 hours of *ad libitum* observations (*sensu* Martin & Bateson, 1993) were made. When it seemed likely that a reproductive event could take place, judging from the swollen abdomen of the females and a general increase of the activity of the fishes, both in movements and number of interactions, videotape recording was performed with a Sony Hi8 CCD-V600 E camera. A total of 120 min of recordings was used to allow subsequent description of courtship and spawning. In the analysis of the film we concentrated in six reproductive sequences, for which it was possible to follow the participants until spawning, although many other interactions took place but could not be followed with sufficient detail. The duration of the interactions was, whenever possible, measured with a digital stopwatch.

Results

A major reproductive event took place on 25 April 2000 in the afternoon (around 5 p.m.) at a temperature of 18ºC and apparently involved most, or all, the fishes present in the aquarium (males and females). It was preceded by a general increase in the movements of the fishes and of the number of interactions among them. In the context of this high level of activity, pairs or small groups of fishes engaged in brief sequences of courtship and spawning.

All sequences were initiated when a male approached a female, laterally or from below. The male began following the female, initially touching her urogenital region with his snout and gradually moving to the flanks and ending in the head region. At this phase, in four out of six interactions, one or more males joined the pair (usually two, three in one case). Several males could follow the female until the end of the reproductive sequence or abandon her, being or not replaced by others. These sequences occurred with the fishes a few cm above the substratum. Alternatively, the fishes could use a vertical surface like the wall of the aquarium (two out of six reproductive sequences). In that case, they moved up and down in circles, keeping their proximity to the wall and swimming with the body tilted in such a way that the abdomen was turned to the wall of the aquarium. When followed by the male(s) females generally tried to escape moving rapidly, being normally pursued through the whole aquarium. The sequences ended either in spawning (four sequences) or by male withdrawal (two sequences). Spawning occurred when a male(s) pressed the female against substratum, large stones or plant clutches, with the individuals keeping their bodies laterally compressed against each other. In such instance, a female was observed spawning simultaneously with three males. However, at this stage, other males may join the group. A maximum number of eight individuals could be counted with certainty in one such group, at least two of them being females. In these groups, the number and the rapid movements of the fish made sex identification and counting of many of the participants uncertain. In those large groups there was a rapid turnover of fishes that entered and left the aggregations, which dispersed and re-formed several times. Although the exact number of fishes could not be determined from the video recordings, it can be stated safely that at least two such spawning aggregations occurred simultaneously in different parts of the aquarium, involving the majority of fishes. We are sure that many of the females spawned during the observations, at least four or five, although we could not determine their exact number.

During spawning, males and females quivered simultaneously and although eggs and sperm release was not visible, fertilized eggs were collected from the sites under the spawning fishes just after these breeding events. These eggs were slightly adhesive, sticking to gravel, stones and aquatic vegetation. The duration of reproductive sequences varied between 18 and 60 sec (n=6, average=27.3 sec). After such a spawning sequence, the fishes normally dispersed, until the onset of the next sequence. In some cases, they stayed in the place where spawning had occurred, revolving the substratum apparently searching for eggs to eat.

Although the reproductive sequences followed the general pattern described above, a few details are worth mentioning. As long as we could see, no agonistic interactions were present between males, both outside and within reproductive sequences, even when several males were following one female.

Although females usually tried to escape males during reproductive interactions, they also seem to display a particular swimming pattern in the water column that apparently was conspicuous enough to attract male attention. Indeed, all instances in which females were observed performing this behaviour were followed by males approach. This pattern occurred at the onset of four of the six reproductive interactions recorded, and was also seen several times during observations, in open areas with good visibility. It was mainly characterized by oblique head up little, but fast, back and forth swimming movements with constant beating of pectoral and caudal fins.

In what concerns male behaviour there was a component that, although not always present in reproductive sequences (in the six sequences it was recorded only two times), was performed normally in interactions between one female and one single male. In this pattern the male displayed a few circles around the female limiting her movements. Between bouts of circles the male touched her flanks and abdomen with his snout.

Discussion

The increase of the general activity of fishes in the onset of the breeding episode observed was also described as an indicator for several cyprinid species (e.g. Svärdson (1952), *Rutilus rutilus*; Breder & Rosen (1966) *Cyprinus carpio*). The reproduction mode observed is broadcasting (e.g. release and abandonment of eggs and sperm over an

unprepared substrate; Johnston, 1999), common to many other cyprinids, referred as primitive for the north American species of minnows and for fish in general by Johnston & Page (1992).

One of the salient features of our observations is the absence of agonistic behaviour in male-male interactions, also related to absence of territoriality. Although this phenomenon is not documented for the Portuguese cyprinid fishes of the genus *Chondrostoma*, there are several descriptions of territorially and aggressive behaviour associated with reproduction in many other species of this family (Miller (1962), *Campostoma anomalum pullum*; Gale (1986), *Cyprinella lutrensis*; Poncin et al. (1996), *Abramis brama*; Wedekin (1996), *Rutilus rutilus*; Johnston (1999), North American genera *Rhinichthys, Cyprinella, Luxilus, Campostoma, Semotilus* and *Nocomis*).

Another interesting feature in the present observations was the existence of a unique female behaviour, that when displayed in the water column could apparently capture male attention and elicit the start of a reproductive sequence. The dynamics of the movements involved and its conspicuousness suggest a possible function as a signal of readiness to mate and an eventual release of pheromones (as suggested by Miller (1962) for *Campostoma anomalum pullum*), but that remains to be tested. As far as we know, such soliciting behaviour by females was not described before for cyprinid fishes. We believe that the role of females in the initiation of courtship deserves special attention, because traditionally much more attention has been given to the action of males in the courtship of fishes, probably in part because it is easier to detect.

The bouts of circles displayed by males around females also deserve further investigation. They occurred normally in interactions involving pairs (one male one female) and we suggest that they play a role in limiting female movements, therefore preventing female escape, a normal feature in the sequences observed.

The behaviour patterns and the spawning sequences described above seem to be specially suited for the type of environment in which this species occurs. The complex swimming movements, with the body tilted to one side, near vertical surfaces, are likely only possible in quiet or slow moving waters. The same applies to the stereotyped head up swimming movements of females, that we suggest are courtship signals for the males and to the circles performed by the male around the female. Finally, the eggs would be quickly swept away in conditions of strong currents.

The notes presented are descriptive and show only the general pattern of reproductive behaviour of this species. More accurate information is needed. One of the problems that require a solution is the almost virtual absence of sexual dimorphism (not common in cyprinids, e.g. Miller (1962), *Campostoma anomalum pullum*; Breder & Rosen (1966), *Gobio gobio* and *Phoxinus phoxinus*; Poncin et al. (1996), *Abramis brama*; Wedekin (1996), *Rutilus rutilus*), with the exception of the swollen abdomen of the females in spawning condition. This feature is not always visible and it is almost impossible to use as a diagnosing character in groups of several rapidly moving individuals, when they spawn in large numbers.

Despite the still preliminary character of this note it is important to consider that reproduction in *C. lusitanicum* occurred among individuals kept in captivity for about one and a half years. This may be a good indicator of the suitability of this species, if necessary, for captive breeding with conservation purposes.

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